To: **Steve Ells, OSRTI Sediment Team Leader**
Silvina Fonseca, OSRTI Regional Coordinator

From: **Kristine Koch and Anne Christopher, Remedial Project Managers, Region 10**

Date: **October 22, 2015**

Re: **Consideration of OSWER Directive 9285.6-08**
Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites;
Portland Harbor Superfund Site, Portland, OR

This Consideration Memorandum describes how the 11 principles outlined in EPA's February 12, 2002, Office of Solid Waste and Emergency Response (OSWER) Directive 9285.6-08 *Principles for Managing Contaminated Sediment Risks at Hazardous Waste* are being considered in the evaluation of the response action for the Portland Harbor Superfund Site ("Portland Harbor"). This Memorandum is submitted to the Contaminated Sediment Technical Advisory Group (CSTAG) in accordance with EPA's February 23, 2006 NRRB Questions and Answers for Superfund Site Managers. Additional information can be found in the Portland Harbor National Remedy Review Board (NRRB) Site Information Package posted on the NRRB website.

SITE BACKGROUND

The Portland Harbor Superfund site is located in the downstream portion of the lower Willamette River, which flows through the city of Portland, Oregon and meets the Columbia River north of the city. The lower Willamette River is a wide, shallow, slow moving segment of the river that is tidally influenced with tidal reversals occurring during low flow periods as far upstream as river mile (RM) 15. The river segment between RM 3 and RM 10 is the primary depositional area of the Willamette River system. The lower reach of the river has been extensively dredged to maintain a 40-foot deep federal navigation channel from RM 0 to RM 11.6. The study area for the Remedial Investigation (RI) of Portland Harbor extends from RM 1.9 (upriver end of the Port of Portland's Terminal 5) to RM 11.8 (near the Broadway Bridge) and data collection for the RI report extends from RM 0.8 to RM 26.4 (above Willamette Falls near Oregon City) (Map 1.0-1).

Portland Harbor has served as the City of Portland's major industrial corridor since the mid 1800's. Important manufacturing, shipping, shipbuilding and timber processing have been conducted along the banks of the river. While the harbor area is heavily industrialized, it occurs within a region characterized by commercial, residential, recreational, and agricultural uses. The lower Willamette River is also an important subsistence fishery for many minority communities of the region. Today, land use along the lower Willamette River in the harbor includes marine terminals, manufacturing, and other commercial operations, as well as public facilities, parks, and open spaces. Map 3.2-8 illustrates land use zoning within the lower Willamette River as well as waterfront land ownership. The State of Oregon owns certain submerged and submersible lands underlying navigable and tidally influenced waters. Depending how the uplands was developed, some upland landowners also own some amount of submerged lands, such as the U.S. Army Corps of Engineers at the U.S. Moorings facility. The long history of industrial and shipping activities in the Portland Harbor, as well as agricultural, industrial, and municipal activities upstream of Portland Harbor, has contributed to chemical contamination of surface water and sediments in the lower Willamette River.

In 2001, EPA entered into a Memorandum of Understanding (MOU) with Oregon Department of Environmental Quality (DEQ), six federally recognized tribes, two other federal agencies, and one other state agency[1], who have all participated in providing support in the development of the Remedial Investigation and Feasibility Study (RI/FS). The site has not been divided into operable units; however, the MOU identifies DEQ as the lead for the identification and control of upland sources within the site. In general, DEQ uses its voluntary cleanup authorities to accomplish source control, including site-specific upland source control studies and implementation of source control measures. However, DEQ has also used its Clean Water Act permitting authorities to accomplish source control.

The Portland Harbor RI/FS for the in-water portion of the site began in 2001 and was compiled by the Lower Willamette Group (LWG) pursuant to an EPA Administrative Settlement Agreement and Order on Consent for Remedial Investigation/Feasibility Study (AOC; EPA 2001a, 2003b, 2006a). Oversight of the Portland Harbor RI and FS is being provided by EPA with support from DEQ. The RI determined that 66 contaminants contribute to unacceptable risk at the site and the most notable contaminants, or focused contaminants of concern (COCs), are polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), 4,4'-dichloro-diphenyl-trichloroethane (DDT) and similar pesticides, and dioxins/furans. The media evaluated for this site includes sediment, biota, surface water, groundwater, and river bank soil.

A Sitewide Proposed Plan and Final Record of Decision (ROD) for Portland Harbor is planned, and the EPA Administrator will sign the ROD. The Preferred Alternative includes a combination of capping, dredging, in-situ and ex-situ treatment, enhanced monitored natural recovery (EMNR), monitored natural recovery (MNR), and institutional controls (ICs). For detailed site information, including background, history, list of COCs, nature and extent of contamination, detailed risk information and evaluation of various alternatives, please refer to the NRRB Site Information Package.

1. CONTROL SOURCES EARLY

A. Briefly identify all significant continuing sources of sediment contamination at the site. For each continuing source, briefing indicate source control actions being taken or to be taken, the expected time to complete these actions, who will undertake them, and how the continuing sources are being monitored.
B. Where there is uncertainty about the timing or effectiveness of source control actions, briefly indicate (1) how the potential for recontamination has been considered in the selection or development of the proposed sediment remedy, and (2) whether the proposed sediment remedy is expected to be beneficial if source control is not effective or not completed by the time the proposed sediment remedy is planned to be implemented.

Historical industrial practices and releases of contaminants dating back to the early 1900s contributed to the majority of the observed chemical distribution in sediments within the study area. Contaminants from upland areas have entered the river system as direct discharges through storm water and waste

1 Government parties that signed the MOU include: the Confederated Tribes and Bands of the Yakama Nation, the Confederated Tribes of the Grand Ronde Community of Oregon, the Confederated Tribes of Siletz Indians, the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes of the Warm Springs Reservation of Oregon, the Nez Perce Tribe, the National Oceanic and Atmospheric Administration, the U.S. Department of the Interior, and the Oregon Department of Fish and Wildlife.

water outfalls and from overwater transloading or other operations that resulted in product or wastes being spilled or dumped into the river.

The majority of the shoreline sites in Portland Harbor have been filled to extend the land surface into the former river channel. The most common fill materials are hydraulically placed sands and silts dredged from the river, although upland investigations have shown waste materials (concrete, slag, asphalt shingles, sandblast grit, etc.), quarry materials, and clean soil have also been used as fill. Though there are no records of the quality of dredge material used for fill, it is likely that the fill materials included contaminated dredge spoils at some locations. Because materials used for fill extend to the riverbank and may not be protected from river flows and erosion in some locations, contaminants have also entered the river system indirectly through overland flow, erosion of the contaminated fill material in the banks, groundwater, and other nonpoint sources. In addition, contaminants from regional sources have reached the study area through inputs of surface water and sediment from upstream and through atmospheric deposition.

Sediments in Portland Harbor reflect the industrial, marine, commercial, and municipal practices for over 100 years in this active industrial, urban, and trade corridor, as well as agricultural activities in the Willamette Basin. Historical sources responsible for the existing contamination include, but are not limited to ship building, repair, and dismantling; wood treatment and lumber milling; storage of bulk fuels and manufactured gas production; chemical manufacturing and storage; metal recycling, production, and fabrication; steel mills, smelters, and foundries; electrical production and distribution; municipal combined sewer overflows; and stormwater from industrial, commercial, transportation, residential, and agricultural land uses. Operations that continue to exist today include bulk fuel storage, barge building, ship repair, automobile scrapping, recycling, steel manufacturing, cement manufacturing, transformer reconditioning, operation and repair of electrical transformers (including electrical substations), and many smaller industrial operations. Locations of both current and historical major industrial operations in Portland Harbor are presented on Map 3.2-10 and Maps 3.2-13 through 3.2-21.

As described in Section B 4.3 of the NRRB Package, ongoing sources of contaminants to the study area include soil, storm water, groundwater, and river banks. Contaminants also reach the river via direct discharge through conveyance systems, atmospheric deposition, and overwater activities. Upstream sources within the broader Willamette River Basin contribute to contamination in sediment, surface water, and biota in the study area.

Identifying the current sources of contamination to the Study Area and eliminating or minimizing these pathways where possible is critical for remedy effectiveness as well as evaluating the recontamination potential of a cleanup. The MOU between DEQ, EPA, and other governmental parties states that DEQ, using state cleanup authority, has lead technical and legal responsibility for identifying and controlling upland sources of contamination that may impact the river (e.g., sediment, groundwater, transition zone water (TZW), and/or surface water). Currently, DEQ is investigating or directing source control work at over 90 upland sites in Portland Harbor and evaluating investigation and remediation information at more than 80 other upland sites in the vicinity (ODEQ 2014). Additionally, DEQ is working with the City of Portland under an Intergovernmental Agreement to identify and control upland sources draining to the Study Area through 39 city outfalls, and with the Oregon Department of Transportation on controlling sources in highway and bridge runoff drained to the Study Area (City of Portland 2012).

Based on a survey conducted by the City of Portland in 2002, approximately 300 individual outfalls that discharge into the Portland Harbor study area have been identified. These individual outfalls are defined as locations of discharge of stormwater, combined sanitary sewage and stormwater, and/or industrial wastewaters transported via a collection system, although most of the latter two are now routed through the sanitary sewer and no longer discharge directly to the waterway. Current municipal and industrial permittees that discharge in the Study Area are listed in Table 4.3-4. The City prepared a combined sewer overflow (CSO) Management Plan (City of Portland 2005) with recommendations to address wet weather overflow discharges, including implementation of storage and treatment facilities along the Willamette River ("Big Pipe project") to control the CSO discharges. The primary means for increasing the storage capacity was through construction of the West Side Tunnel (completed in 2006) and the East Side Tunnel (completed in 2011).

The cleanup of known or potentially contaminated upland sites is tracked in DEQ's Environmental Cleanup Site Information (ECSI) database, which is available online at http://www.deq.state.or.us/lq/ECSI/ecsi.htm, and source control efforts are summarized in DEQ's Portland Harbor Upland Source Control Milestone and Summary Report, which was submitted to EPA on November 21, 2014 (http://www.deq.state.or.us/lq/cu/nwr/PortlandHarbor/jointsource.htm).

Figures 1.2-5a through 1.2-5e graphically display the status of DEQ source control evaluations as of 2014 for various sites along the Study Area by potential release/migration pathways to the river. It is expected that controlling these sources will reduce or eliminate contamination in sediment, groundwater, and surface water in the Willamette River. The report concludes that current and planned cleanup of properties around the Portland Harbor Superfund Site will be sufficient for EPA to effectively implement the in-water remedy without delay. DEQ anticipates updating the 2014 report as progress continues on controls at sites between now and the time of EPA's Record of Decision selecting in-water cleanup methods.

The following is a summary of DEQ's efforts:

- DEQ comprehensively applied the Joint Source Control Strategy, in collaboration with EPA, to identify, evaluate and control contaminant sources from the uplands to the river via groundwater, soil erosion and stormwater.
    - Groundwater source control measures are in place or planned for the groundwater plumes that present a potential to recontaminate river sediment.
    - Riverbanks with potential sources are either being addressed by DEQ efforts or will be integrated into the EPA in-water remedial action.
    - Stormwater contributions from approximately 50% of the drainage area are very clean, originating in Forest Park. CSOs were controlled in 2000-2011. Stormwater source control evaluations were conducted at up to 170 sites following DEQ's Guidance for Evaluating the Stormwater Pathway at Upland Sites. Approximately 90 industrial sites manage on-going stormwater discharges under NPDES permits and another 90 are certified to have no exposure of industrial activities to stormwater. In 2012, DEQ updated its industrial stormwater permit to include: added narrative technology-based and water quality-based effluent requirements; lower metals benchmarks; required professionally engineered corrective actions at facilities that consistently exceed benchmarks; added pollutant monitoring – pollutants listed as impaired in the receiving stream (303(d) listed), additional industrial-related metals (cadmium, chromium and nickel), and sector-specific; more precise sample collection; and prioritized reporting. As a result, the majority of pollutants of concern for Portland Harbor sediment are now monitored in stormwater discharges under

the 1200Z permit. These include: copper, lead, zinc, cadminum, nickel, chromium, chlordane, cyanide, hexachlorobenzene, PCBs, iron, aldrin, DDT, DDE, dieldrin, pentachlorophenol, and PAHs. Because of these efforts, the potential for sediment recontamination via stormwater is low and mechanisms are in place to adaptively manage on-going stormwater discharges.

- Evaluation of the need for upland source control measures is substantially complete and controls are implemented or planned. Source control efforts to date have reduced the threat of recontamination by upland or upstream contaminants. Based on current information and when all planned actions are complete, the risk of recontamination will be reduced sufficiently to allow the in-water remedy to be implemented.
- While source control can be an iterative process, plans and schedules are in place to complete the remaining needed source control measures at individual sites and demonstrate their long term effectiveness prior to implementation of the in-water remedy, as explained in DEQ's 2014 report.
- Going forward, DEQ and EPA will develop an integrated long-term monitoring and adaptive management plan to protect, identify and act on any emergent threats to sediment remedies from upland sources, once put in place.
- The Source Control Summary Report informs development of EPA's preferred alternative.
- An updated report will be available to support public comment on EPA's Proposed Plan.

In response to DEQ's 2014 Summary Report, EPA's main concern is the lack of quality monitoring of the effectiveness of the source control measures that have been implemented to date. Many sites have determined, designed, and implemented source control measures but have "effectiveness pending" notations. EPA has received semi-annual or annual monitoring reports from some of the sites/facilities and others are just beginning their effectiveness demonstrations, but there are still quite a number of sites/facilities that are listed as "pending effectiveness demonstration" for which EPA has not received any monitoring data. There has been a reluctance by many parties to collect data due to the ongoing allocation process for the in-water cleanup as well as a desire to "be done with it" with regards to source control work. EPA will need to play a greater role in the near future in assisting DEQ to get potentially responsible parties to increase the monitoring of their source control measures effectiveness.

In addition to DEQ's oversight of the voluntary agreements for upland contamination removal and remedial actions, some enforcement orders are also in place. Three areas in the site have had some early removal actions overseen by EPA or DEQ in riverbanks and sediment: Gasco (2005), Arco/BP (2007-2008), and Terminal 4 (2008).

After taking into account the early action and source control work already completed for this site, EPA has outlined a remedy that includes a combination of technologies including capping, dredging/excavation, in-situ and ex-situ treatment, and enhanced and monitored natural recovery in one site-wide preferred response action. EPA has incorporated measures into the remedy based on the potential of recontamination from upland sources; for example, the remedy includes sections of riverbanks that DEQ has identified as contaminated which may overlap with DEQ's source control work, and reactive layers have been added to caps where groundwater plumes have the potential to recontaminate the river. It is anticipated that taking action on sediments and sources will reduce contaminant concentrations in all media to acceptable risk levels. The in-river sediment and riverbank action will be a final remedial action.

2. INVOLVE THE COMMUNITY EARLY AND OFTEN

A. Briefly describe the role of the community in the RI/FS and the mechanisms that were used to solicit effective involvement of a variety of community members in sediment-related issues.
B. Briefly describe how local societal and cultural practices were considered in (1) the human health risk assessment (e.g., local recreational use of the water body, local fishing practices) and (2) the selection or development of the proposed remedy (e.g., current and future uses of the water body).
C. Briefly describe the major ways the proposed sediment remedy is expected to affect the local community during remedy implementation.
D. What is the expected level of community support for the proposed sediment remedy? Briefly identify any aspects that are expected to be of great concern and how the expected concerns have been addressed or considered.

One of the roles of the community is to provide input on how to best engage and inform people about the risks and the risk reduction alternatives being considered for the site. EPA's Community Involvement Plan (CIP) is a strategy to help promote meaningful community involvement throughout the cleanup of the Portland Harbor Superfund site. The plan outlines EPA's general and specific activities to continue to complete through the remedial design. The input we received from the community on their concerns, suggested presentations/activities related to the RI/FS, and recommendations on groups that we should engage with, helped inform the CIP. The plan is a working document, updated as more information about the site and from the community becomes available.

The Portland Harbor Community Advisory Group (CAG), which is comprised of local residents and environmental groups, has been active since the site was listed in 2000. During the RI/FS process, EPA has attended and presented at monthly CAG meetings. EPA has also held additional meetings with the CAG and other concerned citizens after each section of the FS was released to answer questions and respond to comments on the draft FS. Since 2001, EPA has awarded a Technical Assistance Grant (TAG), to the Willamette Riverkeeper. The grant is used to hire a technical advisor to support the CAG in understanding and commenting on the RI/FS. Dr. Peter DeFur is the technical advisor for the CAG and is also assisting the CAG draft their letter to the NRRB. EPA consulted with CAG members during the site characterization process because their local knowledge of the best fishing spots proved instrumental during the collection of fish tissue samples. The CAG, other concerned citizens, and environmental organizations helped EPA identify vulnerable populations that most likely consume fish from and/or live along the river. Various ethnic and homeless communities provided input on prime locations where people fish, type of fish they catch and eat, and impacts on homeless communities by possible displacement during remedy implementation. We also heard from non-federally recognized urban Tribal communities about the cultural and ceremonial importance of removing rather than capping contaminated sediment from the River.

In addition to the CAG, EPA has presented to or partnered with various organizations to discuss the human health and ecological risks and the cleanup technologies and alternatives presented in the FS, hear community concerns about the technologies, and hear community suggestions for alternative technologies for sediment remediation. Some of the organizations we have been in contact with include: Communities of Color, Native American Youth and Family Association, Latino Network, Verde, Right 2 Dream Right 2 Survive, the Slavic Immigrant Association, Ecumenical Ministries Oregon, the Coalition of Black Men, the Oregon Environmental Justice Task Force, Oregon Tradeswomen, League of Women Voters, Portland Harbor Community Coalition, Sierra Club Portland, Occupy St. Johns, Audubon

Society, Asian Pacific American Network of Oregon, Vietnamese Community of Oregon, , and the Cathedral Park Neighborhood Association and St. Andrews School. EPA hosted a community café open to the public and used a graphic facilitator to help the community members organize their thoughts about the most important issues and concerns that they have about Portland Harbor. EPA has also provided Portland Harbor 101 information sessions to share information about the project status and hear community concerns and suggestions for reducing risks at the site.

Local societal and cultural practices were considered in both the human health risk assessment and during the development of the proposed remedy. Knowing that many people work for the industries located on the river and that many residents use the river recreationally for swimming, boating and fishing, the current or potentially exposed populations identified in the human health risk assessment were based on current and potential future uses of the river and include: dockside workers, in-water workers, transients, recreational beach users, tribal fishers, recreational and subsistence fishers, divers, people who use the river as a source of drinking water, and infants of dockside and in-water workers, divers, and recreational, subsistence, and tribal fishers. Remedial action objectives (RAOs) 1-4 and 9 were designed to protect human health based on how people are using the river and the potential exposure pathways from sediments, biota (consumption of fish and shellfish), surface water, groundwater, and riverbanks.

Current and future land uses also influenced where certain technologies were assigned in the river for the proposed remedy. In order to maintain the use of the Federal Navigation Channel, future maintenance dredge areas, and other areas with heavy boat traffic, only dredging was assigned to these areas because capping the areas would entail more land use restrictions that would inhibit use of the river. Existing dock structures and local river access points were also considered during technology assignment.

The major ways the proposed sediment remedy is expected to affect the local community during remedy implementation include: light, noise, odors, potential air quality impacts from construction and operation activities 24 hours per day, six days per week, 122 days per year; truck traffic through the community; barge activity in the river inhibiting commercial and recreational access to the river; impacts from construction and operation of a treatment and transport facility and potentially a confined disposal facility (CDF); and fish consumption advisories would continue.

The community supports as much risk reduction and contaminant removal as possible (prefers more dredging than capping) and is not as concerned with the impacts during construction. Community members have told EPA that they are used to the current noise and light pollution from the industries on the river and they prefer the construction to happen more efficiently (24 hours/day, six days/week) if it means that the remedy will be constructed more quickly. While they are less concerned about light and noise pollution, community members have mentioned a preference for barging rather than hauling contaminated sediment with trucks and use of low emission haul trucks if trucks are used, and a concern about monitoring the contractors to ensure work is properly done.

One of the main issues that the community members have vehemently vocalized is their aversion to the use of a CDF for disposal of contaminated sediment. Some community members are concerned about earthquakes (magnitude 9 earthquake from the Cascadia subduction zone), floods, and the CDF serving as an ongoing source of contaminants though as explained by EPA staff, substantial revisions were made to the design addressing all three issues to a higher degree than any other CDF built in the northwest to date. They are also concerned about having the CDF close to their neighborhoods. Knowing that they are opposed to the CDF, EPA included the CDF in the FS as one of two disposal options for the remedy. EPA will use comments received during the Public Comment period to determine which disposal option is most appropriate.

3. **COORDINATE WITH STATES, LOCAL GOVERNMENTS, TRIBES, AND NATURAL RESOURCE TRUSTEES**
    A. Briefly describe the major sediment-related issues in which State and local governments have been involved at the site. Briefly identify any aspects that are expected to be of great concern and how the expected concern has been addressed or considered.
    B. For sites that included water bodies where Total Maximum Daily Loads (TMDLs) are being or have been developed, briefly describe the coordination efforts with the State and with EPA's water program. Identify any aspects of the TMDL that were considered in selection of the proposed remedy.
    C. If there are Tribal interests at the site, briefly identify any aspects of the proposed sediment remedy that are expected to be of great concern and how the expected concern has been addressed or considered.
    D. If there are Natural Resources Trustee interests at the site, briefly identify the major areas of coordination related to the sediment response action. Are Trustee restoration activities expected concurrent with or following the Superfund action?

The 2001 MOU between EPA, DEQ, Tribes, and Trustees outlined the framework for the Technical Coordinating Team (TCT), which is composed of project managers and technical staff from each agency and tribe. The MOU also established a Legal Coordinating Team (LCT) for coordinating on enforcement issues on the RI/FS. During the RI/FS process, the TCT has met once or twice a month to review all technical aspects of the project and to provide comments on all drafted documents before they are finalized. The LCT only meets if an enforcement issue comes up. The EPA Regional Administrator also meets with the DEQ Director regularly.

The NRRB Package includes DEQ's letter of issues and comments about the preferred remedy (Section B 15), which DEQ has written in coordination with other State agencies (OR Department of State Lands, OR Department of Transportation, etc.) and Governor's office. DEQ has reviewed the draft FS and has said that it is adequate for EPA to recommend a preferred remedy based on the logic of the FS. DEQ will present the following key comments on the remedy to the NRRB:

- Cost – What can be cut?
- Treatment of Principal Threat Waste – Value added?
- Navigation and other uses – Minimize restrictions and impediments
- Technology assignments – Benefits of dredging outside navigation area?
- Remedial Design – Flexibility
- MNR – Concerns with model and inconclusive empirical data
- Effectiveness and residual risks – Focus on hot spot areas
- RALs – Modify/Refine?
- Contingency Remedies –EMNR?
- DEQ will comment on EPA's Proposed Plan
- State will determine concurrence on EPA's Record of Decision

The list of impaired waters in Oregon prepared under Section 303(d) of the federal CWA and its amendments includes the main stem and tributaries of the Willamette River. In 2008, the 303(d) listings in the lower Willamette River (RM 0 to 24.8 as defined by DEQ)[2] included aldrin, DDT, DDE, dieldrin, iron, manganese, mercury, PCBs, PCP, PAHs, temperature, and bacteria. Johnson Creek, a tributary that enters at RM 18, is listed for toxic chemicals, including dieldrin, DDT, PAHs, and PCBs. DEQ has developed total maximum daily loads (TMDLs) for temperature, bacteria, dieldrin, and DDT in Johnson Creek to reduce these watershed contaminants. DEQ's 303(d) list of impaired waters above Willamette Falls includes numerous tributaries of the Willamette River. The 303(d) listings in the main stem above Willamette Falls include aldrin, arsenic, DDT, DDE, dieldrin, iron, manganese, mercury, PCBs, dissolved oxygen (DO), temperature, and bacteria. Most of the 303(d) listings for the upper Willamette River tributaries are for temperature and bacteria; other listings relate to nutrients, DO, turbidity, and pH. In addition, smaller creeks in the middle and upper Willamette sub-basins are listed for dieldrin, heptachlor, dichloroethene, tetrachloroethene, trichloroethene, arsenic, copper, iron, lead, manganese, mercury, or zinc.

Based on the 303(d) list, DEQ has developed TMDLs for 11 of the 12 Willamette River sub-basins (Table 4.5-3; DEQ 2006). TMDLs are currently being developed for the Yamhill sub-basin. Temperature, bacteria, and mercury TMDLs have been issued for all Willamette River sub-basins and the main stem. A PCDD/F TMDL was developed by USEPA in 1991 for the Willamette and Columbia rivers. In 2012, EPA added chlordane, cyanide, and hexachlorobenzene to the 303(d) toxic pollutant list for the Lower Willamette River. Further reduction in watershed contaminants will likely occur as a result of TMDL implementation and other future watershed toxic reduction efforts.

The NRRB Package also includes letters of Tribal issues and comments about the FS (Section B 15). One letter is from the Yakama Nation and the other letter is from the other five tribes. The Tribes are generally most concerned about residual risk left in the river, not wanting to rely on MNR, and the continued need for fish advisories in the long-term. The Tribes would prefer that EPA selects the most aggressive remedy to reduce residual risk as much as possible by the end of construction. Yakama Nation is specifically worried about the impacts that the Portland Harbor cleanup will have on the Columbia River and the salmon migration because a lot of money is spent to clean up the Columbia River and to protect salmon.

The Natural Resource Trustees have already begun some restoration work in the river. They have approved a restoration project owned and developed by a local subsidy of Wildlands, Inc. on Sauvie Island close to Multnomah Channel at the site of a former lumber mill site.

4. DEVELOP AND REFINE A CONCEPTUAL SITE MODEL THAT CONSIDERS SEDIMENT STABILITY

A. Attach a copy of the conceptual site model (e.g., one or more diagrams or charts, not numerical models) for sediment which identifies contaminant sources, contaminants of concern, affected media, existing and potential exposure pathways, and human and ecological receptors that may be threatened.

B. Identify the natural and man-made disruptive forces that were considered and how they were considered when evaluating sediment alternatives. Where appropriate, identify the intensities of recurrence intervals of the forces, e.g. hurricane rating, flood recurrence interval and briefly explain why the intensities of recurrence intervals were chosen.

[2]For most recent listing see: http://www.deq.state.or.us/wq/assessment/rpt0406/results.asp

A pictorial representation illustrating the major elements of the conceptual site model (CSM) (sources, pathways, fate and transport mechanisms, and human and ecological receptors) for the Portland Harbor Study Area is shown in Figure 10.1-1, while Figure 10.1-2 presents a graphical conceptualization of the sources, release mechanisms, transport media, and exposure media of the CSM. The human health and ecological CSMs for the Portland Harbor Site are summarized in Section B 4.1 of the NRRB Package. Figure 3-1 presents the CSM for the Baseline Human Health Risk Assessment (BHHRA) and the ranges of estimated potential risks resulting from the different exposure scenarios are summarized in Table 8.4-1. Figure 9.6-1 presents the complete and significant exposure pathways that were quantitatively evaluated in the Baseline Ecological Risk Assessment (BERA) using multiple lines of evidence.

Sediment stability varies within Portland Harbor based on both natural and man-made forces. Areas of the river range from depositional, erosional, and transitional and the site is tidally influenced, so sediment stability changes throughout the site and can vary seasonally in a given area. Boat traffic in the navigation channel and around dock structures also impacts sediment stability due to prop scour, wakes, and anchoring.

Section B 4.2.4 of the NBBR Package explains the bathymetry and sediment characteristics of Portland Harbor. Map 3.1-9 shows that most of the study area is from –30 to –50 ft CRD (–25 to –45 ft NAVD88) and is dominated by the authorized federal navigation channel, which runs from RM 0 (Columbia River) to RM 11.7 (Broadway Bridge) and extends nearly bank-to-bank from RM 4 to 6 and again from RM 8 to 11.7. Except along the western channel edge from RM 8 to 10 where extensive shoaling has occurred, these portions of the study area have very narrow and steeply sloped off-channel areas. There are also some broader off-channel areas with shallow benches (–10 to –30 ft CRD) and there are several deep areas in the harbor that extend from –60 to –80 ft CRD. Map 3.1-13 shows the long-term bathymetric changes that occurred in the lower Willamette River between 1888 and 2001. This map was produced by overlaying and subtracting the 2001 bathymetric survey data from 1888/1895 bathymetric data provided by the City of Portland[3] and illustrates the large-scale deepened, diverted, and filled areas.

The primary factors controlling river flow dynamics, sediment deposition and erosion, and riverbed character appear to be the river cross-sectional area and navigation channel width. The upstream boundary of the study area to Willamette Falls is markedly narrower, more confined by bedrock outcrops, and faster flowing than the Portland Harbor reach. The river widens as it enters the study area and becomes increasing depositional, most notably in the western portion of the river, until RM 7. From approximately RM 5 to RM 7, the river and navigation channel narrows, and this reach is dominated by higher energy environments with little deposition. From RM 5 to approximately RM 2 the river widens again and becomes depositional, particularly in the eastern portion of the river. Immediately downstream of the study area, the river narrows as it turns and converges with the Columbia River. Multnomah Channel exits at RM 3, considerably reducing direct discharge to the Columbia River.

Sediments in some locations may be resuspended and transported downstream during periods of high flow and from anthropogenic disturbances, such as vessel operations in the harbor. The degree of deposition and movement of sediments is controlled largely by river hydrodynamics and the sediment

3 Bathymetric data provided by the City of Portland was based on a GIS digital model developed using the United States Coast & Geodetic Survey 1888 Columbia River chart (Fales Landing to Portland) and USACE 1895 surveys of the Upper Willamette (Sheets 14 and 15).

texture (grain size and organic matter content). Suspended fine-grained sediments (silts and clays) are typically transported farther than larger sandy sediments under all flow conditions.

Bathymetric changes from 2002 to 2009 show the greatest net sediment accumulation occurs where the channel is wide and where flow velocities are reduced. These shoals are predominantly fine-grained sediments. Some areas of natural scour and dredging are also evident. Sediments in the scour areas are predominately sand and appear to be relatively stable during low-flow conditions, but are mobilized when flow velocities are high.

Nearshore and off-channel areas, such as Swan Island Lagoon, Willamette Cove, and port terminals, also exhibit deposition. In other areas, such as RM 9 to 11E, areas within Swan Island Lagoon and Willamette Cove, RM 6 to 7W, and RM 5 to 7E, little elevation change and/or small-scale scour was observed. Sediment scour in some nearshore locations appears to be due to ship traffic (wakes and prop wash) and other human activities. These activities also appear to mix surface and subsurface sediments.

Over the past 150 years, the Willamette River has experienced numerous floods. The Willamette River flows generally increase in response to regional storms due to the comparatively small size of the basin. Figure 2-66 shows the flow rates in the Lower Willamette River and Table 2-1 shows the estimated flow rates for high-flow events. Record winter floods (1964 and 1996) occurred when periods of heavy snowfall at lower elevations were followed by warming periods and heavy rains, resulting in rapid increases in runoff. During the floods of 1964 and 1996, the river fully occupied its historical floodplain in the lower, narrower portion of the river and much of the mid-river portion as well. In some locations, low-lying contaminated riverbank soils can be prone to erosion, and potentially contribute to sediment contamination in the river. These low-lying bank areas are particularly prone to erosion during periodic flooding events.

Sediment stability based on natural and anthropogenic factors was incorporated into the technology assignments of capping and dredging within the sediment management units in all of the alternatives, as described in Section B 8 of the NRRB Package. Determining the appropriate dredging or capping technology to assign is dependent on a number of site-specific characteristics and environmental conditions. These factors include current and reasonably anticipated future land and waterway use, areas of erosion/deposition, sediment bed slope, infrastructure such as docks and piers, and physical sediment characteristics.

The technology application process considers site characteristics in the SMAs so that remedial approaches most appropriate for site conditions (anthropogenic and environmental) are developed and applied in particular areas. EPA's 2005 Guidance (particularly the series of "highlights" of site characteristics conducive to particular remedial approaches; Highlight 4-2, 5-1, 6-2, and 7-2) and other resources describe site characteristics consistent with remedial approaches (EPA 1991; USACE 2008, ITRC 2014).

5. USE AN ITERATIVE APPROACH IN A RISK-BASED FRAMEWORK

A. A. Briefly describe the major ways in which an iterative approach was used at the site. (We define "iterative approach" broadly to include approaches that incorporate testing of hypotheses and conclusions and foster re-evaluation as new information is gathered.)

B. Briefly describe any early or interim actions planned or implemented at the site that address threats from contaminated sediment.

C. If the proposed sediment remedy will be implemented in phases or if it is part of a larger phased approach to the site as a whole, briefly describe the phases.

EPA has used an iterative approach for this site in the following ways:

- As described in Principle One above, DEQ has been working to control the upland sources of contamination before the in-water remedy work begins under EPA lead.
- EPA Enforcement Actions for Early Action work at the site
    - Terminal 4 site: Port of Portland signed an Administrative Settlement Agreement and Order on Consent for Removal Action with EPA Region 10 on October 2, 2003. This was to include pre-ROD site cleanup and CDF construction. However, for a variety of reasons, the project was divided into two phases. Phase I, taking place pre-ROD, included removal of sediments deemed to exceed imminent and substantial endangerment levels, as well as a 60 percent CDF design to give input to the harbor wide Portland Harbor FS on the viability of the CDF, and to provide cost information that is similar in detail and accuracy as other upland, commercial facilities. The Phase I Abatement Measure was completed in 2008 and consisted of remediation and maintenance dredging of approximately 13,000 cubic yards of sediment. Remediation consisted of dredging 6,315 cubic yards of contaminated sediment and placing it in an off-site disposal facility, isolating contaminated sediment in the back of Slip 3 with a cap made of organoclay-sand mix, and stabilizing the bank along Wheeler Bay.
    - Arkema site: Arkema Inc. signed an Administrative Order on Consent for Removal Action with EPA Region 10 on June 27, 2005. Under this Order, Arkema has not performed cleanup, but has gathered additional data to advance pre-design level analysis.
    - U.S. Moorings site: U.S. Army Corps of Engineers was issued a RCRA 3013 Administrative Order in June 2007. The USACE investigated ongoing upland sources under the order. The two pathways of potential ongoing sources found during the investigation was an area of low level contaminated soils that could migrate to the river and a cyanide plume originating from the facility to the south of the Corps facility daylighting in front of the facility. The Corps addressed the erodible soils in 2015 and DEQ is working with NW Natural next door to control the cyanide plume.
    - Triangle Park site: University of Portland signed a Bona Fide Prospective Purchaser Agreement and Order on Consent for Removal Action with EPA Region 10 on December 26, 2006 and an Amendment on April 16, 2009. Under the PPA, the University of Portland completed a removal action for a 35-acre former industrial site with soil and groundwater contamination.
    - Gasco site: An Administrative Order on Consent was signed on April 15, 2004 to conduct a removal of visibly eroding manufactured gas plant waste from the Willamette River. Approximately 15,000 tons of pure tar material were removed in 2005. NW Natural and Siltronic Corporation signed a second Administrative Settlement Agreement and Order on Consent for Removal Action with EPA Region 10 on September 9, 2009. Under this agreement the companies have conducted pre-design studies and have agreed to complete design of a cleanup adjacent to their facilities after the ROD is issued.
    - River Mile 11E Project Area: Cargill, Inc., CBS Corporation, City of Portland, DIL Trust, Glacier Northwest, Inc., and PacifiCorp signed an Administrative Settlement Agreement and Order on Consent for Supplemental RI/FS Work with EPA Region 10 in April 2013. Under this order, the parties are conducting supplemental RI/FS studies to advance the pre-design and design level of information about the area which has high PCB concentrations in sediment and biota.

- Other Superfund sites within Portland Harbor:
  - McCormick and Baxter Superfund site: Remedy completed in September 2005. DEQ lead for O&M at site.
  - Gould Superfund site: Remedy completed in September 2000 and was deleted from the NPL in 2002. Five year reviews are still conducted because waste is left in place.
- For all of the alternatives developed for this site, the remedy was designed as a decision tree logic and matrix of criteria to determine which remedial technologies should be assigned where within the site. Footprints of each technology assignment have been developed in the FS based on the current data set that EPA has for the site; however, these footprints are subject to change based on new site information. Recently, new sediment data were collected to study the rate at which MNR is occurring in the river. New baseline data will also be collected during the Remedial Design phase of the cleanup process. All new data will be considered during Remedial Design and each area of the river will be evaluated with the decision tree to determine the appropriate remedial technology. Throughout construction and post construction, the site will be monitored to ensure that the remedy is performing as expected. If the remedy needs to be changed or updated due to new information, different or additional work may be required through a ROD amendment or Explanation of Significant Differences (ESD).
- EPA anticipates that hot spots of contamination will be focused on for remediation first, generally sequenced starting upriver and moving downriver. The remedy is designed to have active remediation up front and then to rely on MNR post construction to further reduce contaminant levels and meet PRGs. If monitoring proves that MNR is not occurring or not occurring fast enough, additional work may be required.

6. CAREFULLY EVALUATE THE ASSUMPTIONS AND UNCERTAINTIES ASSOCIATED WITH SITE CHARACTERIZATION DATA AND SITE MODELS

A. Briefly identify the most important continuing uncertainties associated with site characterization data and, where applicable, with qualitative or quantitative models, including input parameters, which were important (1) to the human health and ecological risk assessments and (2) to the evaluation of potential sediment remedies. Briefly explain how those uncertainties were accounted for (e.g., use of sensitivity analyses or reasonable conservative assumptions.)

B. Identify any computer models used in the assessment of the site or evaluation of sediment alternatives. For each model or model group, indicate whether the model or model application was peer-reviewed and if so, briefly indicate whether that review was internal or external to EPA.

The main source of uncertainty for the Portland Harbor remedy is the ability to model sediment transport in the river and to predict how long MNR will take to reach PRGs post construction. Section B 13.2 of the NRRB Package explains the issues with the LWG's hydrodynamic and sediment transport (HST) model and the Sed CAM model that EPA used. EPA commissioned external expert reviews of the HST model (Jay 2012, Hayter ??), which identified several shortcomings that limit its usefulness in predicting sediment transport within Portland Harbor. EPA has concluded that the HST model predictions are inconsistent with the CSM for this site, as it shows significant concentration reductions occurring within the first 10 years. However, given that the majority of the contamination was released into the river 30-80 years ago and similar reductions have not been observed, the model results appear inconsistent with the empirical data collected during the RI.

EPA believes there is too much uncertainty in the current version of the HST model predictions to quantify the predicted reductions in sediment concentrations due to natural processes such as sediment deposition. The FS compared each alternative based on the contaminant concentrations at time zero post-construction when MNR would begin. EPA is in the process of refining the LWG's model and will evaluate how effective the new model is at predicting the rate of natural recovery in the river once it is built.

Three important data gaps for this site include limited fish tissue data that is comparable from one dataset to another to assess if there have been contaminant reductions in biota, limited dioxin/furan sampling, and detection limit issues with multiple contaminants. Additional samples will be collected during Remedial Design to fill in these data gaps.

7. SELECT SITE-SPECIFIC, PROJECT-SPECIFIC, AND SEDIMENT-SPECIFIC RISK MANAGEMENT APPROACHES THAT WILL ACHIEVE RISK-BASED GOALS

A. Briefly list all risk management approaches of alternatives that were evaluated for remediation of contaminated sediment at the site. Where this list does not include some form of each of the three major sediment cleanup methods (i.e., capping, monitored natural recovery, dredging, and/ or combinations of these), briefly explain why the method was not appropriate for evaluation.
B. Briefly outline the proposed sediment remedy for the site and how it relates to any other sediment operable units at the site.

The focus of the Portland Harbor cleanup will be on those areas that have the highest levels of toxic and persistent contaminants and whose cleanup will have the most impact on reducing risks to human health and the environment. EPA believes the best cleanup approach is one that sufficiently reduces risk in the areas where contamination is highest to allow for MNR to achieve cleanup levels in a reasonable time frame. Risk reduction predictions over a long period of time, through modelling, are complex and uncertain (as described in Principle 6 above). Remedial actions will focus on reductions in concentrations of contaminants in sediment and riverbank soils. These remedial actions, in conjunction with source control measures, are anticipated to reduce concentrations in other media as well, such as groundwater, surface water, biota, upland soils, and air.

Seven alternatives were developed in the FS, are labeled A-G, and are described in Section B 8.2 of the NRRB Package. Alternative A is a No-Action alternative and Alternatives B-G all use a combination of the following general response actions (GRA) to varying degrees: ICs, MNR, EMNR, containment, sediment treatment (in-situ and ex-situ), sediment/soil removal, and disposal of dredged sediments. As explained in Principle 4 above, remedial technologies were assigned based on contaminant concentrations, the physical characteristics of the sites within the river, and anthropogenic impacts from current and potential future uses of the river. Based on the Conceptual Site Model, MNR has not occurred sufficiently in the areas with high contaminant concentrations, so more aggressive technologies such as capping and dredging are needed to address these areas. In-situ treatment will be used as a component of reactive caps for groundwater plume areas and to address principle threat waste (PTW) that is not removed. EMNR and MNR will be assigned to areas with lower contaminant concentrations throughout the site and MNR will be relied on post construction to ultimately reach remediation goals.

In reviewing the risk reductions and comparative analysis of the alternatives, EPA determined that no individual alternative was the best remedy for the river. To help inform the best balance among active remediation, cost, and MNR, EPA conducted further evaluation of, including but not limited to, the following areas:

- MNR effectiveness
  - Long Term Modeling Projections
  - Changes in bathymetry (underwater depth, due to sediment deposition and erosion)
  - Contaminant concentration trends in smallmouth bass (a small home-range fish)
- In-situ and ex-situ treatment technology assumptions
- Combination of alternatives to achieve greater risk reduction cost-effectively at construction complete
  - Focus on hot spot areas (Sediment Decision Units (SDUs))
  - Apply and evaluate different alternatives in each SDU
  - Evaluate the need for construction activities outside SDUs
  - Minimize long term restrictions in the river

As described in Section B 11 of the NRRB Package, EPA has selected Alternative E as the preferred alternative. However, after analyzing the factors listed below, EPA has recognized that some areas of the site could apply a less aggressive alternative than Alternative E, while more aggressive alternatives was most appropriate in other areas to meet the criteria below. The site was broken into thirteen individual regions of the river which were designated as SDUs. SDUs were generally identified as areas where focused COC rolling 1 RM averages concentrations were the highest (Figures 4.1-1a through 4.1-1ac). The resulting preferred alternative consists of Alternative E in all SDU's except the following:

SDU 5.5E – Alternative F

SDU 6.5E – Alternative B + PTW

SDU 6NAV – Alternative B + PTW

SDU 6W – Alternative D

SDU 7W – Alternative F

Areas outside SDUs – PTW only

This selection was based on the following factors:

- Addressing majority of PTW
- Meeting regulatory requirements for treatment of PTW, when applicable.
- Meeting ecological PRGs for RAOs 5 and 6 through construction since ICs do not work
- Minimizing need for ICs for human health PRGs for RAOs 1 and 2.
- Construction resulting in meeting RAOs 3 and 7 for surface water and RAOs 4 and 8 for pore water.
- Minimizing recontamination potential from river banks.
- Limiting need for waterway use restrictions from caps.
- Maximizing permanence through removal of highly contaminated sediments.
- Reducing residual risks at construction completion for RAO 1 to less than 1×10^{-5} (State ARAR) and HI less than 10. MNR is expected to meet PRGs (10-6 and HI=1).

- Reducing residual risks at construction completion for RAO 2 to less than 10-4 and HI less than 10 (child). MNR is expected to meet background risk levels of 7 x 10^{-5} and HI = 1.
- Reducing residual risks at construction completion for RAO 5 to HI less than 10. MNR is expected to meet PRGs.
- Reducing residual risks at construction completion for RAO 6 to HI less than 10. MNR is expected to meet PRGs.

8. ENSURE THAT SEDIMENT CLEANUP LEVELS ARE CLEARLY TIES TO RISK MANAGEMENT GOALS

A. What remedial action objectives (RAOs) or removal objectives were developed to address the human health and ecological risks associated with contaminated sediment?
B. Briefly describe the sediment cleanup and action levels, including how they were derived and how they relate to the RAOs or removal objectives.

The human health and ecological risks associated with contaminated sediment are explained in Section B 6 of the NRRB Package.

Remedial action objectives (RAOs) consist of media-specific goals for protecting human health and the environment that specify COCs for each media of interest; exposure pathways, including exposure routes and receptors; and an acceptable contaminant concentration or range of concentrations for each exposure route. As explained in Principle 7, remedial actions focused on reductions in concentrations of contaminants in sediment and riverbank soils, in conjunction with source control measures, are anticipated to reduce concentrations in other media as well, such as groundwater, surface water, biota, and riverbanks. Nine RAOs were developed for the Portland Harbor site, which are described in Section B 7 of the NRRB Package, and are listed below:
Human Health

- **RAO 1** – **Sediments:** Reduce cancer and noncancer risks to people from incidental ingestion of and dermal contact with COCs in sediments and beaches to exposure levels that are acceptable for fishing, occupational, recreational, and ceremonial uses.
- **RAO 2** – **Biota**: Reduce cancer and noncancer risks to acceptable exposure levels (direct and indirect) for human consumption of COCs in fish and shellfish.
- **RAO 3** – **Surface Water:** Reduce cancer and noncancer risks to people from direct contact (ingestion, inhalation, and dermal contact) with COCs in surface water to exposure levels that are acceptable for fishing, occupational, recreational, and potential drinking water supply.
- **RAO 4** – **Groundwater:** Reduce migration of COCs in groundwater to sediment and surface water such that levels are acceptable in sediment and surface water for human exposure.

Ecological

- **RAO 5** – **Sediments:** Reduce risk to ecological receptors from ingestion of and direct contact with COCs in sediment to acceptable exposure levels.
- **RAO 6 – Biota (Predators):** Reduce risks to ecological receptors that consume COCs in prey to acceptable exposure levels.
- **RAO 7** – **Surface Water:** Reduce risks to ecological receptors from ingestion of and direct contact COCs in surface water to acceptable exposure levels.

- **RAO 8** – **Groundwater:** Reduce migration of COCs in groundwater to sediment and surface water such that levels are acceptable in sediment and surface water for ecological exposure.
- **RAO 9 – River Banks:** Reduce migration of COCs in river banks to sediment and surface water such that levels are acceptable in sediment and surface water for human health and ecological exposures.

The preliminary remediation goals (PRGs) are described in Section B 7 of the NRRB Package. The PRGs are developed on the basis of site-specific and default risk-related factors, chemical-specific applicable or relevant and appropriate requirements (ARARs), when available, and consideration of background concentrations. Risk-based PRGs were developed to address unacceptable human health and ecological risks identified in the BHHRA and BERA, consistent with the NCP [300.430(e)(2)(i)]. These PRGs represent concentrations in environmental media which are protective of both human and ecological receptors for each RAO. Some PRGs will be met post construction, but EPA is unable to predict at this time when all PRGs will be met throughout the river post construction through MNR processes.

9. MAXIMIZE THE EFFECTIVENESS OF INSTITUTIONAL CONTROLS AND RECOGNIZE THEIR LIMITATIONS

A. A. Briefly list any ICs that are part of the proposed sediment remedy. Describe any plans to maximize their effectiveness (e.g., public education regarding fish consumption advisories.

B. Briefly describe any plans for on-going monitoring and gathering of information at the site which may indicate the effectiveness of ICs.

As described in the Section B 8 of the NRRB Package, ICs are common elements in all of the alternatives evaluated in the FS. Existing Oregon Health Authority (OHA) fish consumption advisories would continue under any of the remedial actions. Further, enhanced outreach to educate community members about the ODOH consumption advisories and to emphasize that advisories would remain in place during and after remediation would be incorporated into the active remedial alternatives. Outreach activities would focus on communities (typically communities or groups with environmental justice concerns) known to engage in sustenance fishing, with a special emphasis on sensitive populations (children, pregnant women, nursing mothers, tribal members). These activities could also include posting multilingual signs in fishing areas, distributing illustrated, multi-lingual brochures, and holding educational community meetings and workshops.

Additional ICs such as waterway and land use restrictions or special conditions (to protect the integrity of engineered caps) imposed on sediment disturbance activities will also be implemented as components of alternatives comprising active remedial measures.

Waterway Use Restrictions or Regulated Navigation Areas (RNAs): Where caps will be utilized to contain contamination, waterway use restrictions or RNAs will be necessary to ensure the integrity of the cap is maintained. This will include prohibiting anchoring of vessels or the use of spuds to stabilize vessels in areas containing caps. Notifications such as signs and buoys placed by the Oregon Marine Board may be used to warn vessels from the area. RNAs have been successfully used in the past to protect remedial actions at the Site. RNAs were required to protect the McCormick and Baxter cap and the Gasco interim action cap from vessel activities.

Periodic inspections of RNA notifications will be needed to ensure they are functional and effective.

Land Use/Access Restrictions: Land use or access restrictions may need to be implemented in nearshore areas and riverbanks to maintain the integrity of caps. DSL has promulgated administrative rules (OAR 140, Chapter 145) that control use of State-owned submerged or submersible land for activities related to a remedial action. Monitoring, including inspections, will be needed to ensure that restrictions are functioning as intended.

Additional monitoring and gathering of information which may indicate the effectiveness of ICs are described in response to Principle 11 below.

10. **DESIGN REMEDIES TO MINIMIZE SHORT-TERM RISKS WHILE ACHIEVING LONG-TERM PROTECTION**
Briefly list the cleanup methods or natural processes to be used to achieve long-term protection at the site, the length of time expected to achieve RAOs or removal objectives, and how short-term risks of implementing those methods are minimized. Remedy-specific examples are listed below:
    A. For in-situ capping, list: 1) the physical, chemical, and biological processes that are most important to cap design to ensure long-term protection at this site, and 2) measures that will be required to minimize contaminant releases, during cap placement, and 3) monitoring of the cap to ensure protectiveness.
    B. For dredging, briefly describe the measures that will be required to minimize releases and short-term risks during dredging, treatment (if any), and transport. If on-site disposal is planned, briefly describe the disposal unit and monitoring that will be required to assess protectiveness.
    C. For monitored natural recovery, list: 1) the major physical, chemical, and/or biological processes that will be relied upon to achieve and maintain long-term protection at the site, and 2) any measures that will be required to minimize risks during the recovery period.
    D. Briefly list the major expected effects of the proposed remedy on societal and cultural practices and how this was considered in remedy selection.

As described in Section B 8 of the NRRB package, for all of the alternatives, the cleanup methods or natural processes that will be used to achieve long-term protection at this site include a combination of the following: capping, dredging, in-situ and ex-situ treatment, EMNR, and MNR. EPA does not currently have a model that can reliably predict the time expected to achieve RAOs through MNR processes post construction, so the alternatives have been evaluated based on the risk reduction when construction is complete.

Capping: Engineered, reactive, and armored caps have been assigned throughout the river and are generally between two to three feet thick depending on site-specific conditions related to erosive forces, chemical isolation requirements, and habitat requirements. Cap thickness is dependent on site-specific considerations that will be addressed in remedial design. Armored caps will be used to reduce erosion and reactive caps will be used where there are contaminated groundwater plumes or PTW. Resuspension/release during construction activities will be addressed through operational best management practices (BMPs) and engineered control measures. ICs to restrict land uses, such as, Waterway Use Restrictions or RNAs, or environmental easements and equitable servitudes, would be implemented to ensure residual risks are contained within the capped areas. Additionally, coordination with federal and state regulatory authorities on future permitting actions that may affect caps or other remediated areas would likely be needed. Monitoring requirements are explained below under Principle 11.

To minimize the expected impact of cap materials on the recolonization of the cap by biota, caps designed for shallow areas of the river must include dredging first before cap placement to maintain the same water depth. If the cap needs to be armored, a beach mix will be used to keep the cap texture similar to the original beach/riverbank composition and to maintain a similar aquatic environment.

Dredging: To reduce risks during dredging, the duration of the dredging season is assumed to be 123 days based on an in-water fish work window established for the Willamette River of July 1 through October 31. This in-water work window accounts for fish migration patterns and may be refined following discussions with the relevant technical experts from the natural resource trustees. Monitoring programs, actions to address any water quality exceedances (such as increased dredge cycle times if water quality exceedances are resulting from dredging activities), and specific water quality criteria will be applied at the Site.

Environmental/closed buckets are assumed for mechanical dredging of sediments to lessen releases to the water column. Dredging BMPs can greatly lessen contaminated sediment releases, residuals, and resuspension. Dredging is assumed to occur during the approved in-water work window when river currents are low enough to use silt curtains and engineered rigid control measures will be used in areas with NAPL. A 12-inch sand layer is assumed for all dredge areas once 95 percent of dredging is complete (and the potential need for additional dredging passes to reach the desired dredge depth will be lessened) in an area to control residuals and releases. In areas where PTW is present, five percent activated carbon is assumed to be mixed with the residual layer. During excavation, riverbank material will be susceptible to erosion from wind and surface water runoff. Erosion control measures will be used to either divert surface water flows/runoff around and away from excavations or limit offsite transport of eroded riverbank materials. Balancing of dredge and fill volumes will limit flood rise concerns throughout the Site.

Dredged material will be dewatered, treated, and transported as needed. Dredged sediment with concentrations of PCBs and dioxins/furans that do not exceed regulatory standards that require treatment can be reliably contained in a landfill, so they will be disposed of untreated. An additional evaluation will need to be conducted on dredged sediment containing any PTW related to NAPL, PAHs or DDx. Thus, ex-situ treatment is applied to dredged sediment and soil containing these contaminants. A confined disposal facility (CDF) at Terminal 4 has been presented as a disposal option for some of the alternatives. The monitoring requirements are described below under Principle 11.

MNR/EMNR: Natural recovery typically uses ongoing, naturally occurring processes to contain, destroy, or reduce the bioavailability or toxicity of contaminants in sediment. These processes may include physical (sedimentation or dispersion), biological (biodegradation), and chemical (sorption and oxidation) mechanisms that act together to reduce the risks posed by contaminants. For the purposes of the FS, it is expected that physical isolation through natural deposition of cleaner material and dispersion and mixing are the primary mechanisms for natural recovery at the Site. MNR includes monitoring to assess the effectiveness of these natural processes, but does not include physical remedial measures. Key aspects of the conditions for MNR include incoming sediment particle concentrations, sediment deposition rates, and monitoring.

Analysis of data collected during RI indicates that MNR is not occurring in Swan Island Lagoon at a rate sufficient to reduce risks within an acceptable time frame. There is limited water circulation within Swan Island Lagoon, limiting the rate of sediment deposition. Therefore, EMNR is being considered for the area in Swan Island Lagoon that is outside the SMAs and FMD areas to reduce risks. EMNR is accomplished through the placement of a 12-inch layer of sand, which is sufficient to allow for mixing with the underlying sediment bed, while also retaining clean sand above the mixed interval. In areas where PTW is present, 5 percent activated carbon is added to the sand layer. ICs will be used to prevent or limit exposure to contaminants on both a short-term and long-term basis.

Effects on Societal and Cultural Practices: Many people use the river recreationally, some fish for cultural reasons or for sustenance, and many businesses use the river commercially for shipping. Everyone's ability to enjoy or use the river will be restricted during the years of remedy construction. EPA is heavily weighing the amount of risk reduction needed post construction against the number of years of construction because we understand that remedy construction will cause a significant disruption to the surrounding neighborhoods and to the city as a whole. The FS has considered ways to make the construction process as efficient as possible (24 hours per day, 6 days per week dredging) during the fish window (July 1-October 31) and will determine if an additional fish window can be added per year in order to decrease the overall construction time needed for each of the alternatives.

Community members generally oppose the construction of a CDF at this site, but they also do not want trucks driving contaminated sediment through their communities, which would increase traffic and noise and air pollution. EPA has been researching other disposal options, which could include barging the contaminated sediment up the Columbia River to an existing transloading or disposal facility.

11. **MONITOR DURING AND AFTER SEDIMENT REMEDIATION TO ASSESS AND DOCUMENT REMEDY EFFECTIVENESS**
    A. Briefly describe the type of monitoring that will be required to assess contaminant releases during remedy implementation (i.e., during dredging, during cap placement, or during the recovery period in the case of monitored natural recovery.)
    B. For each medium that has a cleanup level or remedial action objective listed in the answer to #8A above, briefly describe the type of monitoring (including physical, biological, and chemical monitoring) that will be required to determine whether the levels and objectives are met, and whether sufficient baseline data are available. Where they are not, briefly indicate plans for additional data collection prior to implementation of the remedy.
    C. Briefly indicate other plans for long term monitoring (e.g., monitoring of long-term success of source control measures, effects of disruptive events, migration of buried contaminants, cap integrity).

As discussed in Section B 8 of the NRRB package, monitoring will be required in all alternatives except A during and after remediation to assess and document remedy effectiveness. The monitoring requirements will be established in the Proposed Plan and in the Record of Decision. The details of the monitoring plan will be developed during remedial design and likely further refined post remedy construction.

Capping: Monitoring will be conducted to evaluate long-term effectiveness. The monitoring program will include sediment, surface water, pore water, and fish tissue samples collected at the following frequencies:

- Remedial Baseline Monitoring will be conducted prior to implementation of remedial activities to gage the performance of the remedy.

- Long-term Monitoring will commence the year following completion of remedy implementation and take place every 2-3 years for the first 10 years and once every 5 years thereafter. Statutory 5-year reviews of the protectiveness of the remedy will be conducted in perpetuity.

Capping would be effective in limiting exposure to risks posed by COCs in the sediments and riverbank soils provided the integrity of the caps is maintained. Therefore, the caps would need to be monitored and maintained in perpetuity. Reviews at least every five years, as required, would be necessary to evaluate the effectiveness of any of these alternatives because hazardous substances would remain on-site in concentrations above levels that allow for unlimited use and unrestricted exposure.

Operation and maintenance activities, ICs and long-term monitoring will be implemented to assure protectiveness and reliability of caps and thin layer covers. The following paragraphs further describe how these activities maintain the protectiveness and reliability of these controls:

- O&M will be required for material left in place and may include bathymetric surveys and diver performed monitoring at regular intervals to confirm the thickness of thin layer sand covers and capping materials. In addition to regular surveys, supplemental surveys will be performed following episodic natural and anthropogenic events that have the potential to disturb caps and sand covers.

- ICs include governmental controls, proprietary controls and informational devices. The reliability of ICs can be enhanced through activities such as regular inspection of buoys and other devices to delineate regulated navigation areas, administrative procedures and inspections to ensure the maintenance of co-located structures and ongoing public outreach efforts to enhance the effectiveness of informational devices. Coordination will need to occur with federal and state regulatory authorities during future permitting activities that may disturb subsurface contaminated sediment or capped areas. Additional ICs would be necessary to maintain cap integrity in perpetuity. Fish consumption advisories, which rely on voluntary compliance, would be enhanced by additional outreach to improve their effectiveness in reducing risk to human health by limiting exposure to COCs.

- Monitoring of the effectiveness of the remedial alternative would include sampling of the water column, sediment, and biota tissue before, during and after construction to verify that risks to the ecosystem continue to decrease. The planned post-construction monitoring program would result in collection of the data necessary to determine whether the fish consumption advisory or other restrictions imposed as part of the remedial action could be relaxed. Tissue PRGs based on the consumption of 19 eight-ounce fish meals per month were developed for use during the post-construction monitoring period to evaluate if contaminant concentrations are decreasing toward PRGs as expected.

Dredging: Monitoring will be conducted to evaluate contaminant releases during dredging. The monitoring program will include surface water and air samples collected at the following frequencies:

- Remedial Baseline Monitoring will be conducted prior to implementation of remedial activities to gage the performance during dredging activities.
- Short-term Remedial Monitoring will be conducted regularly during implementation.

EMNR in the River and in Swan Island Lagoon: Monitoring will be conducted to evaluate long-term effectiveness. The monitoring program will include sediment, surface water, pore water, and fish tissue samples collected at the following frequencies:

- Remedial Baseline Monitoring will be conducted prior to implementation of remedial activities to gage the performance of the remedy.
- Short-term Remedial Monitoring will be conducted every 2 years during implementation of remedial measures.
- Long-term Monitoring will commence the year following completion of remedy implementation and take place every 2-3 years for the first 10 years and once every 5 years thereafter until remedial goals are achieved.

MNR in Remaining Areas of River: Monitoring will be conducted to evaluate the long-term effectiveness. The monitoring program will include sediment, surface water, pore water, and fish tissue samples collected at the following frequencies:

- Remedial Baseline Monitoring will be conducted prior to implementation of remedial activities to gage the performance of the remedy.

- Short-term Remedial Monitoring will be conducted every 2 years during implementation of remedial measures.

- Long-term Monitoring will commence the year following completion of remedy implementation and take place every 2-3 years for the first 10 years and once every 5 years thereafter until remedial goals are achieved.

Air Monitoring during Construction: There would be potential risks to construction workers during construction due to air-quality issues associated with dust, odor, and vehicular exhaust; however, measures such as air monitoring on-site and at the site boundary, and engineering controls would control the potential for exposure.

CDF: Construction of and on-site disposal of materials in a CDF (in DMM Scenario 1 in Alternatives E, F and G) would impose short-term impacts to the community. However, the impacts during filling of the CDF would be minimized by monitoring air quality and water quality and through implementation of BMPs.

Source Control Monitoring: DEQ will continue to monitor its source control measures to prevent recontamination of the in-water remedy.